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TWO CASES OF ENUCLEATION OF THE EYE, FOR THE PREVENTION OF SYMPATHETIC OPHTHALMIA.

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J. F. B., aged 10, was brought to me Oct. 13th, 1863. He had been fishing that morning in company with another boy, who, in swinging his line preparatory to a cast, had transfixed the eye of his companion with the hook. Various efforts made to withdraw it served only to fix it more deeply in the eye. I saw the patient some four hours after the occurrence of the accident. The hook had entered the right eye near the extreme lower edge of the cornea, had passed upwards, transfixing the iris and the lens, and buried itself to within about four lines of the end of the shank. The crystalline was already opaque, and a portion of it had become detached and fallen forward into the anterior chamber. The patient was suffering extreme pain.

Considering the efforts that had already been made to extract the hook, as well as the point at which it had entered the eye and the severe injury this organ had already suffered, it was felt that so extensive an operation as must of necessity be undertaken for the removal of the hook offered a comparatively slight chance of restoring vision, and would in all probability be followed by that tedious inflammation of the iris and ciliary region so peculiarly liable to be followed by sympathetic ophthalmia of the sound eye. The patient was therefore etherized and enucleation performed, after the method of Bonnet, the conjunctiva being divided close to the cornea and the six muscles and optic nerve at their very insertions into the ball, thus leaving as much as possible in the orbital cavity, and affording a better cushion for an artificial eye. In twelve days one was introduced, and has been worn with advantage up to the present time.

H. R., aged 19, a native of Smyrna, called on me Sept. 24th of the present year. At the age of 4 he had received a severe blow on the left eye from an ivory-headed cane, a projecting portion of

the carving of which probably penetrated the eye, though whether any piece had been broken off and remained in the eye he is unable to say. A severe inflammation ensued, completely destroying vision on this side. Ever since, the eye has been subject to inflammatory attacks, lasting about fourteen days at a time, and occurring some four times a year.

On examination, the left eye was found but little altered, either as to tension or size. Much congestion of the deep ciliary vessels existed, the cornea was entirely opaque within about half a line of its upper edge, its area being occupied by an uneven leucoma bearing evidences of frequent ulceration. No perception of light existed. The right seemed in every respect perfectly normal, both as to vision and the ophthalmoscopic appearances. Patient had observed, however, of late, a growing inability to use this eye for any length of time, especially in the evening, without considerable uneasiness, watering and injection. This is more particularly the case after an attack of inflammation in the other.

No doubt was felt as to propriety of surgical interference in the present case. The left eye was irretrievably lost. The frequent attacks of inflammation in it, occurring with such frequency and extending over so many years, required to be put an end to, both on account of the annoyance they caused, and the danger the sound eye ran of being ultimately affected, if indeed the symptoms of irritability it was already exhibiting were not the forerunners of a sympathetic ophthalmia.

Two methods of operating presented themselves—the one being the reduction in size of the eyeball so as to admit of the wearing of an artificial eye over the stump thus formed; the other, the removal of the whole ball by enucleation. The former plan could be carried out either by removing the anterior half of the eyeball and allowing the remainder to cicatrize, or by running a silken thread through the ball to excite a purulent choroiditis and consequent atrophy of the bulb. Either of these methods would leave a better stump on which to place an artificial eye than enucleation; were open, however, as it seemed, to grave objections—partial abscission of the bulb not unfrequently being followed by annoying hæmorrhage, and entailing a tedious convalescence; while, on the other hand, if the eye at present under consideration contained a foreign body, or bony deposits had formed in its interior, its reduction in size would result in leaving an irritable stump, which would itself have to be removed at a future day, until which time the danger of a sympathetic ophthalmia would not be passed.

Enucleation was therefore decided on, and performed Sept. 27th. Not more than two drachms of blood was lost, and the patient left his bed within forty-eight hours. Oct. 7th, he commenced wearing an artificial eye, and is now attending to his business as usual.

On examination of the eye thus removed, the globe was found to

be of normal dimensions, the sclerotic being in the posterior half so thin in many places as distinctly to reveal the hue of the choroidal pigment. A section of the globe being made, the cornea was found to be much thickened, the lens shrunken and chalky. The retina was wholly detached from the choroid, hanging away from its attachments at the ora serrata on all sides, and extending in the shape of a funnel to the optic nerve, around the edges of which it was closely applied. Overlying the choroid and easily separable from it, was a bony shell or scale, one inch in length and seven lines in width, accurately moulded on the eye. At its thickest point or centre its thickness was about a line and a half, tapering away to the edges, which were exceedingly fragile. At its outer edge a well-marked foramen existed, for the passage of the retina to the optic nerve.

In each of these cases enucleation was undertaken, not to relieve any existing serious disease, but to guard against a sympathetic affection, the occurrence of which was considered probable. Sympathetic ophthalmia, or that form of inflammation which arises in one eye in consequence of traumatic inflammation of its fellow, has been of late the subject of careful investigation at the hands of several distinguished observers. An obstinate and slow affection, prone to relapses, exercising a most disastrous effect on vision, and—when fairly established--resisting treatment of whatever nature, it can only be averted with certainty by the excision of the eye that is likely to produce it.

According to Von Graefe, the most common causes of sympathetic ophthalmia are:—

1st. The presence of a foreign body as a permanent source of irritation.

2d. The form of inflammation of the iris and ciliary bodies known under the name of "irido-cyclitis," especially liable to occur when the seat of injury is near the ciliary region.

3d. Recurrent intra-ocular hæmorrhages, with rapid changes of tension.

4th. The presence of bony concretions.

Both the cases now reported come under one of these headings, and it is probable that had enucleation not been resorted to, the vision of the other eye would ultimately have become impaired. In brief, the principle may now be regarded as established, that "in injuries of the eye which give rise to a lengthy irritation, particularly those involving the ciliary region, the injured eye should be removed, even though its fellow have not become affected, to avert intractable inflammation and danger of entire blindness."

Dr. Dunlap, of Springfield, Ohio, has experienced most gratifying effects from the use of permanganate of potash in the treatment of "spotted fever," as it appeared recently in that city. In the more malignant cases, the dose was from $\frac{1}{8}$ to $\frac{1}{2}$ gr. frequently repeated.

DR. GAILLARD'S PRIZE ESSAY ON OZONE; ITS RELATIONS TO HEALTH AND DISEASE.

[Continued from page 256.]

HOWEVER the various branches of the subject of ozone may interest the chemist and philosopher, it is to its therapeutic and hygienic relations that the physician turns for study and examination. We propose, then, to make these, with the physiological relations of ozone, the concluding portions of our essay.

We have seen that ozone is a direct stimulant to animal and vegetable life. We know that the most vital changes take place during the aëration of the blood in its passage through the lungs, and we can readily appreciate the effect which must be produced by the exposure of this fluid to a highly oxygenated gas. It is natural that the inhalation of ozone should have been first attempted, in producing the effect of this agent upon the animal economy. It must be recollected, however, that one 2000th part of ozone in an atmosphere would make it fatal to small animals; and very little more than this, fatal to man. In an atmosphere giving 10 as the register of the ozonometer, ozone exists in the proportion of one 10,000th part. The point of vital difficulty is to charge an atmosphere with a sanitary amount of ozone, and to avoid the possibility of this being exceeded. It is possible to charge the atmosphere of a room to any required degree of the ozonometer, but it has so far been found impracticable to avoid the diffusion of ozone to an unsafe degree. Its therapeutical use, by inhalation, has not been sufficiently practicable or safe to render its adoption advisable. Experiments are constantly being made, with a view of obviating these difficulties, and of introducing ozonized air into hospitals, ships in dangerous latitudes, and localities requiring a safe and efficient disinfectant. Ozonized oil of turpentine has frequently been used for these purposes, but there are objections to its odor and want of ozonic concentration which must prevent its general introduction. Experiments of the most promising and interesting character in this connection are now being made by Dr. Richardson, of London. He uses ozone, as found in peroxide of hydrogen, formed by the action of hydrochloric acid on the peroxide of barium. Ozone and the peroxide of hydrogen, he considers one and the same thing. Ozone is thus introduced in a concentrated state into water, and we have therefore a simple and efficient mode of using this agent. It forms, in this condition, a powerfully deodorizing lotion. As a disinfectant and deodorizer, it promises the best results. It is chiefly interesting, however, in its physiological and therapeutical relations, and we will for the present postpone its farther consideration.

It will be seen that ozone must soon become popularly known and appreciated for its hygienic properties. The air coming from the sea is highly ozonized; ozone being there largely formed, and but

little consumed. The cheering effect of sea-air was known and advised by the earliest writers of the profession, who not appreciating the cause, yet by a vague compliance with the teachings of tradition, happily profited by its effects.

M. Schönbein has submitted to the Society of Naturalists at Bâle the results of many experiments in regard to the effect of ozonized oil of turpentine upon the animal economy. These experiments are certified by Professors Seitz and Fraas, of Munich. The ozonized oil of turpentine was thus prepared by them:—"The oil of turpentine is placed in white bottles, of which it fills only the quarter or half of each bottle, and is then freely exposed to sunlight. From time to time, each bottle is opened, so that the atmospheric air may have free ingress. The oil thus prepared has the smell and taste of peppermint oil; smelling disagreeably, tasting hot and bitter, and giving to the tongue a peculiar sensation of pain and cold." From experiments on animals, it is found that on the mucous membrane of the mouth and digestive organs, the ozonized oil acts like the simple oil, irritating and causing an increased flow of saliva and mucus. "It is rapidly absorbed; the pulse increases in fulness and frequency; the respirations are quickened, and, where large quantities are given, become painfully rapid." If the doses are frequently repeated, inflammation of the endocardium and pericardium ensues, with dangerous congestion of the lungs. Small doses act as excitants to the nervous system, but large doses cause paralysis, convulsions, stupor and death.

Seitz, in his experiments with the ozonized oil of turpentine, discovered facts of therapeutic value. The simple and ozonized oils he found passed off through the kidneys and lungs; giving to the secretions of the kidney the usual violet odor, and, to the exhalations from the lungs, the smell of the ordinary oil. The ozonized oil was given, with good effect, in chronic cystitis and in incontinence of urine, in menorrhagia and hæmatemesis, in gout and rheumatism. In sciatica, it produced speedy relief, and was found very beneficial in vesical catarrh, hæmaturia, and many other vesical disorders. It has given marked relief in facial neuralgia. The dose, for these purposes, is from ten to thirty drops, in an emulsion or on sugar. Seitz especially recommends it in gout and rheumatism. According to the testimony of Schnepf and Abt, of Vienna, twenty to thirty drops of the ozonized oil are quite sufficient for arresting mortal hæmorrhages; this testimony is endorsed by Eschach and Knolz, of the same city. The ozonized oil relieves, very frequently, chronic discharges from the mucous passages. Dr. Richardson, in his use of the aqueous solution of ozone (peroxide of hydrogen in water) finds it "an antidote for the alkaloidal poisons"; that as an "external application to decomposing sores, as an internal remedy in fever, where the patient literally dies from deficient oxygen, and in diabetes, *the medicine* might be used with the very best promises of success. In the way of

a pleasant, acid drink, one could give, to the typhus-stricken man, 100 cubic inches of active oxygen per hour. In diabetes, under the administration of this remedy, the quantity of sugar at once became less, and the excretion of urine decreased." Tetanus and other diseases are mentioned, but these facts are quite sufficient to awaken an interest in the therapeutic applications of the aqueous solution of ozone. It is given as prepared by Dr. Richardson, and detailed in an early part of this essay ("charged with ten volumes of the peroxide"), in doses of from one to four fluid drachms in distilled water. It is given compatibly with all the mineral acids. From the effects of oxygen on albumen, fibrin, and on the blood, it would not be irrational to conclude that ozone should have a happy effect on the lymphatic, chlorotic and anæmic; on all of those who suffer from the devitalizing influences of imperfect sanguification. These results have not, until recently, been very successful or important, but after years of hope and disappointment, experiment and defeat, the sanguine expectations of many are about to be realized.

We have received from Dr. Theophilus Thompson, Physician to the Hospital for Consumption, London, the results of his observations on the medical administration of ozonized oils. The sanguine and the skeptical will each be interested in the simple record of his experience. Dr. Thompson, in his experiments, used oil ozonized after the method of Mr. Dugald Campbell. This does not sufficiently differ from the manner of preparing ozonized oil of turpentine, as recommended by Seitz and others, to render a detailed description necessary. It is only necessary to say, that the oils were *first* saturated with simple oxygen, and then exposed, for a long time, to the direct rays of the sun. One indication of the satisfactory progress of the process is the appearance, says Dr. Thompson, "of a peculiar acid, watery-looking fluid at the bottom of the vessel; it may also be mentioned, that the fact of the oils being charged with ozone can be rendered obvious by the usual tests; the bleaching properties which they possess and the action which they exert upon preparations of iodide of potassium and starch." We will give brief extracts from cases sent us, and a few conclusions which their history suggests.

Case.—Male; laborer; æt. 33; phthisis in the first stage; dull percussion, prolonged expiratory murmur, wavy inspiration, increased vocal resonance on the right side. Admitted October 8th. Took salines for two days; then two drachms of ozonized sunflower oil, twice a day. Pulse reduced in a few days from 104 to 92. Left hospital on Oct. 22d.

Case.—Similar to last; weight seven stone, twelve and a quarter pounds. Took salines; then ozonized sunflower oil, three times a day. Pulse 118; in ten days fell to 102; in four days from this, 86; weight increased one pound and a quarter. The ozonized oil becomes exhausted; in three days pulse rises to 108.

Case.—Age, 8. Vomica of right lung, with tubercular deposition. Took cod-liver oil twice a day, oil being ozonized. In three days pulse fell from 120 to 100. Oil was then given three times a day; in less than a week, the pulse was reduced to 80.

Case.—Age, 28. Vomica and softened tubercle. Under the use of ozonized oils, pulse not influenced; 90 throughout.

Case.—Tubercular deposit in both lungs, advanced to softening on one side. Admitted Sept. 22d; weight nine stone and a half pounds. Took simple cod liver oil to Dec. 10th; pulse 112. Ordered ozonized oil; pulse gradually fell to 76. On Jan. 6th, simple cod-liver oil resumed; pulse on the 13th 108. Ozonized oils resumed; on 15th, 17th and 19th pulse fell to 88; then to 84. Ozonized oil withdrawn, and simple coco-oleine then given; pulse rose to 92. Ozonized coco-oleine given; pulse falls to 86.

Case—Phthisis. Took simple cod-liver oil for three weeks; pulse 90. Ozonized oil given; pulse falls to 68.

Case.—Under the use of ozonized oils pulse at 100; oils discontinued, pulse rises to 110.

These cases, as is obvious, are not selected; the full effect and the want of effect in the treatment being *both* detailed. There are many more given by Dr. Thompson, but we wish to avoid detail. We have, for a faithful representation of the subject, given cases exhibiting the varied effects of the therapeutical administration of the ozonized oils. We have given the most unfavorable cases reported by Dr. Thompson, and have certainly selected many that were not the most favorable.

It is proper to give the testimony of Dr. Scott Alison, who had charge of the Hospital, during the temporary absence of Dr. Thompson. "Under my directions, only four of the patients had ozonized oil given in such a manner as to be likely to afford any result. Unfortunately, all of the patients were in the third stage of the disease, and no lasting benefit was experienced. In two cases, a remarkable reduction in the frequency of the pulse took place, during the use of the ozonized oils—the reduction amounting to about twenty-five beats—whilst the improvement could not be referred to any other cause. I attach some value to this observation, for I prescribed the oil, totally divested of all prejudice in its favor, and I have always been reluctant, on imperfect grounds, to refer results to the operation of medicines. If ozonized oil can reduce the rapidity of the circulation, a feature of great importance in phthisis, this remedy possesses a most valuable property; rendered still more valuable by its contributing to improve the general health."

Dr. Thompson observes, that in order to appreciate the evidence adduced, it is important to notice that in some of the patients the use of simple and ozonized oil was more than once alternated, with a marked and corresponding variation of effect. In one case, the alternation was made three times, and the result was so direct and

remarkable as to make this particular case equivalent, in válue, to three cases. It is impossible to review the history of these cases without being convinced *that the administration of ozonized oils has a most remarkable tendency to reduce the frequency of the pulse, in addition to producing a decided improvement in the general health and condition of the consumptive patient.* In fourteen of the cases, sent by Dr. Thompson, there are *only two* in which no effect of this kind was produced. In the majority of instances the improvement was marked, and must be attributed only to the ozone, and not to the oil, since it was manifested in patients who had taken cod-liver oil and other oils, without any reduction in the frequency of the pulse; in some, under the use of simple oils the pulse was even accelerated, and under the administration of ozonized oil became immediately reduced. The effect on the pulse was nearly as distinct, when ozone was associated with cocoa-nut oil, or sun-flower oil, as it was with the cod-liver oil. The oils first mentioned produce no effect unless associated with ozone.

The reduction in the frequency of the pulse, produced by the administration of ozonized oils, is indeed remarkable. It is usually observable in two or three days. Dr. Thompson states, in connection with this subject, that "a reduction of twenty beats was observed, in certain cases, in two, three, four and six days: in other instances, there was a reduction of twenty-four pulsations in fourteen days; of thirty-four pulsations in thirteen days; of thirty-six pulsations in twenty-two days; and of forty pulsations in eleven days." In one patient, the pulse fell to 60; in most of the favorable cases, the reduction ceased when the normal standard was attained. This abstract, of Dr. Thompson, is of course taken from a large aggregate of cases. Such facts require no comment. We shall give none; for they demonstrate truths which cannot be misinterpreted or misunderstood.

[To be continued.]

ON THE NORMAL MOTIONS OF THE HUMAN EYE.

By Prof. Hermann Helmholtz, For. Memb. R.S.

The motions of the human eye are of considerable interest, as well for the physiology of voluntary muscular motion in general, as for the physiology of vision. Therefore I may be allowed to bring before this Society the results of some investigations relating to them, which I have made myself; and I may venture, perhaps, to hope that they are such as to interest not only physiologists and medical men, but every scientific man who desires to understand the mechanism of the perceptions of our senses.

The eyeball may be considered as a sphere, which can be turned round its centre as a fixed point. Although this description is not

absolutely accurate, it is sufficiently so for our present purpose. The eyeball, indeed, is not fixed during its motion by the solid walls of an articular excavation, like the bone of the thigh; but, although it is surrounded at its posterior surface only by soft cellular tissue and fat, it cannot be moved in a perceptible degree forward and backward, because the volume of the cellular tissue, included between the eyeball and the osseous walls of the orbit, cannot be diminished or augmented by forces so feeble as the muscles of the eye are able to exert.

In the interior of the orbit, around the eyeball six muscles are situated, which can be employed to turn the eye round its centre. Four of them, the so-called *recti* muscles, are fastened at the hindmost point of the orbit, and go forward to fix themselves to the front part of the eyeball, passing over its widest circumference—or its equator, as we may call it, if we consider the foremost and hindmost points of the eyeball as its poles. These four *recti* muscles are from their position severally named superior, inferior, internal and external. Besides these, there are two *oblique* muscles, the ends of which come from the anterior margin of the orbit on the side next the nose, and, passing outwards, are attached at that side of the eyeball which is towards the temple—one of them, the superior oblique muscle, being stretched over the upper side of the eyeball, the other, or inferior, going along its under side.

These six muscles can be combined as three pairs of antagonists. The internal and external *recti* turn the eye round a perpendicular axis, so that its visual line is directed either to the right side or to the left. The superior and inferior *recti* turn it round a horizontal axis, directed from the upper end of the nose to the temple; so that the superior *rectus* elevates the visual line, the inferior depresses it. Lastly, the *oblique* muscles turn the eye round an axis which is directed from its centre to the occiput, so that the superior oblique muscle lowers the visual line, and the inferior raises it; but these last two muscles not only raise and lower the visual line; they produce also a rotation of the eye round the visual line itself, of which we shall have to speak more afterwards.

A solid body, the centre of which is fixed, and which can be turned round three different axes of rotation, can be brought into every possible position consistent with the immobility of its centre. Look, for instance, at the motions of our arm, which are provided for at the shoulder-joint by the gliding of the very accurately spherical upper extremity of the humerus in the corresponding excavation of the scapula. When we stretch out the arm horizontally, we can turn it, first, round a perpendicular axis, moving it forwards and backwards; we can turn it, secondly, round a horizontal axis, raising it and lowering it; and, lastly, after having brought it by such motions into any direction we like, we can turn it round its own longitudinal axis, which goes from the shoulder to the hand; so that even when the

place of the hand in space is fixed, there are still certain different positions in which the arm can be turned.

Now let us see how far the motions of the eye can be compared to those of our arm. We can raise and lower the visual line, we can turn it to the left and to the right, we can bring it into every possible direction, throughout a certain range—as far, at least, as the connections of the eyeball permit. So far the motions of the eye are as free as those of the arm. But when we have chosen any determinate direction of the eye, can we turn the eye round the visual line as an axis, as we can turn the arm round its longitudinal axis?

This is a question the answer to which is connected with a curious peculiarity of our voluntary motions. In a purely mechanical sense, we must answer this question in the affirmative. Yes, there exist muscles by the action of which those rotations round the visual line can be performed. But when we ask, "Can we do it by an act of our will?" we must answer, "No." We can voluntarily turn the visual line into every possible direction, but we cannot voluntarily use the muscles of our eye in such a way as to turn it round the visual line. Whenever the direction of the visual line is fixed, the position of our eye, as far as it depends upon our will, is completely fixed and cannot be altered.

This law was first satisfactorily proved by Professor Donders, of Utrecht, who, in a very ingenious way, controlled the position of the eye by those ocular spectra which remain in the field of vision after the eye had been fixed steadily during some time upon any brightly colored object. I have used for this purpose a diagram, of which the ground is grey paper, and in the middle is placed a narrow strip of red paper on a broader strip of green paper. The centre of the red strip is marked by two black points. When you look for about a minute steadily, and without moving your eye, at the centre of the diagram, the image of the colored strips is projected on the nervous membrane of your eye; those parts of this membrane on which the light falls are irritated, and in consequence of this irritation, their irritability is exhausted, they are fatigued, and they become less sensitive to that kind of light by which they were excited before. When you cease, therefore, to look at the colored strips, and turn your eye either to the grey ground of the diagram, or to any other part of the field of vision which is of a uniform feeble degree of illumination, you will see a spectrum of the colored strips, exhibiting the same apparent magnitude, but with colors reversed, a narrow green strip being in the middle of a broader red one. The cause of this appearance is, that those parts of your retina which were excited formerly by green light are less affected by the green rays contained in white or whitish light than by rays of the complementary color, and white light, therefore, appears to them reddish; to those parts of the nervous membrane, on the other hand, which had been fatigued by

red light, white light afterwards appears to be greenish. The nervous membrane of the eye in these cases behaves nearly like the sensitive stratum in a photographic apparatus, which is altered by light during the exposure in such a way that it is impressed differently afterwards by various agents; and the impression of light on the retina may be, perhaps, of the same essential nature as the impression made upon a photographic plate. But the impressiom made on the living eye does not last so long as that on sensitive compounds of silver; it vanishes very soon if the light be not too strong. Light of great intensity, like that of the sun when directly looked at, can develope very dark ocular spectra, which last a quarter of an hour, or even longer, and disturb the perception of external objects very much, as is well known. One must be very careful to avoid the use of too strong a light in these experiments, because the nervous apparatus of the eye is easily injured by it; and the brightness of these colored strips, when illuminated by common daylight, is quite sufficient for our present purpose.

Now you will perceive easily that these ocular spectra are extremely well adapted to ascertain the position of the eyeball, because they have a fixed connection with certain parts of the retina itself. If the eyeball could turn about its visual line as an axis, the ocular spectrum would apparently undergo the same degree of rotation; and hence, when we move about the eye, and at last return to the same direction of the visual line, we can recognize easily and accurately whether the eye has returned into the same position as before, or whether the degree of its rotation round the visual line has been altered. Professor Donders has proved, by using this very delicate test, that *the human eye, in its normal state, returns always into the same position when the visual line is brought into the same direction.* The position and direction of the eye are to be determined in this case in reference to the head of the observer; and I beg you to understand always, when I say that the eye or its visual line is moved upwards or downwards, that it is moved either in the direction of the forehead or in that of the cheek; and when I say it is moved to the left or to the right, you are to understand the left or right side of the head. Therefore, when the head itself is not in its common vertical position, the vertical line here understood is not accordant with the line of the plummet.

Before the researches of Donders, some observers believed they had found a difference in the relative positions of the eye, when the head was brought into different situations. They had used either small brown spots of the iris, or red vessels in the white of the eye, to ascertain the real position of the eyeball; but their apparent results have been shown to be erroneous by the much more trustworthy method of Donders.

In the first place, therefore, we may state that the position of the eyeball depends exclusively upon the direction of the visual line in

reference to the position of the head of the observer. But now we must ask, what is the law regulating the position of the eye for every direction of its visual line? In order to define this law, we must first notice that there exists a certain direction of the visual line, which, in relation to the motions of the eye, is distinguished from all other directions of the eye; and we may call it the *central* or *primary direction of the visual line.* This direction is parallel to the median vertical plane of the head; and it is horizontal when the head of the observer, who is standing, is kept in a convenient erect position to look at distant points of the horizon. How this primary direction of the visual line may be determined practically with greater accuracy we shall see afterwards. All other directions of the visual line we may call *secondary directions.*

A plane which passes through the visual line of the eye, I call *a meridian plane* of the eye. Such a plane cuts through the retina in a certain line; and when the eye has been moved, we consider as the same meridian plane that plane which passes through the new direction of the visual line and the same points of the retina as before.

After having given these definitions, we may express the law of the motions of the eye in the following way:—

Whenever the eye is brought into a secondary position, that meridian plane of the eye which goes through the primary direction of the visual line has the same position as it has in the primary direction of the eye.

It follows from this law that the secondary position of the eye may be found also by turning the eye from its primary position round a fixed axis which is normal as well to the primary as to the secondary of the visual line.

It would take too long to explain the different ways in which different observers have tried to determine the law of the motions of the eyeball. They have employed complicated apparatus for determining the angles by which the direction and the rotation of the eye were to be measured. But usually two difficulties arise from the use of such instruments containing graduated circles, in the centre of which the eye must be kept steady. In the first place, it is very difficult to fix the head of the observer so firmly that he cannot alter its position during a continuous series of observations, and that he reassumes exactly the same position of the head when he returns to his measurements after a pause—conditions which must necessarily be fulfilled if the observations are to agree with each other. Secondly, I have found that the eye must not be kept too long a time in a direction which is near to the limits of the field of vision; else its muscles are fatigued, and the positions of the eyeball corresponding to different directions of the visual line are somewhat altered. But if we have to measure angles on graduated circles, it is difficult to avoid keeping the eye too long in directions deviating far from the primary direction.

I think that it depended upon these causes, that the observations carried out by Meissner, Fick and Wundt agreed very ill with each other and with the law which I have explained above, and which was first stated by Professor Listing of Göttingen, but without any experimental proof. Happily, it is possible, as I found out, to prove the validity of this law by a very simple method, which is not subject to those sources of error I have named, and which I may be allowed to explain briefly.

In order to steady the attitude of the head in reference to the direction of the visual line, I have taken a little wooden board, one end of which is hollowed into a curve fitting the arch of the human teeth; the margin of this hollow is covered with sealing wax, into which, after it had been softened by heat and had been cooled again sufficiently, I inserted both series of my teeth, so that I kept it firmly between my jaws. The impressions of the teeth remain indented in the sealing-wax; and when I put my teeth afterwards into these impressions, I am sure that the little board is brought exactly into the same position, relatively to my head and my eyes, as it was before. On the other end of that little board, which is kept horizontally between the teeth, a vertical piece of wood is fastened, on which I fix horizontally a little strip of card pointed at each end, so that these two points are situated about five inches before my eyes, one before the right eye, the other before the left. The length of the strip of card must be equal to the distance between the centres of the eyes, which is 68 millimetres for my own eyes. Looking now with the right eye in the direction of the right point of that strip, and with the left eye in the direction of the left point, I am sure to bring the eyes always into the same position relatively to my head, so long as the position of the strip of card on the wooden piece remains unaltered.

As a field of vision I use either a wall covered with a grey paper, in the pattern of which horizontal and vertical lines can be easily perceived, or a drawing-board covered with grey drawing-paper, on which a system of horizontal and vertical lines is drawn, and colored stripes are fastened along a central perpendicular line *a b*.

Now the observer at first must endeavor to find out that position of his eyes which we call the primary position. In order to do this, the observer takes the wooden piece between his teeth, and brings his head into such a position that his right eye looks to the centre of the colored stripes, in a direction perpendicular to the plane of the drawing. Then he brings his head into such an attitude that the right end of the card-strip appears in the same direction as the centre of the colored stripe. After having steadily looked for some time to the middle of the colored stripe, he turns away his gaze to the end of either the vertical or horizontal lines, which are drawn through the centre of the colored stripe. There he will see an ocular spectrum of the colored stripe, and will observe if it coincides

with the horizontal lines of the drawing. If not, he must alter the position of the strip of card on the wooden bar to which it is fastened, till he finds that the ocular spectrum of the colored stripe remains horizontal when any point either of the line *a b* or the central horizontal line *c d* is looked at. When he has thus found the primary direction of his visual line for the right eye, he does the same for the left.

The ocular spectra soon vanish, but they are easily renewed by looking again to the centre of the stripes. Care must be taken that the observer looks always in a direction perpendicular to the plane of the drawing whenever he looks to the centre of the colored stripe, and that he does not move his head. If he should have moved it, he would find it out immediately when he looks back to the strip, because the point of the card-strip would no longer cover the centre of the colored stripe.

So you see that the primary direction of the visual line is completely fixed, and that the eye, which wants only to glance for an instant at a peripheral point of the drawing, and then goes back again to the centre, is not fatigued.

This method of finding the primary position of the eye proves at the same time that vertical and horizontal lines keep their vertical or horizontal position in the field of vision when the eye is moved from its primary direction vertically or horizontally; and you see, therefore, that these movements agree with the law which I have enunciated. That is to say, during vertical movements of the eye the vertical meridian plane keeps its vertical position, and during horizontal movements the horizontal meridian.

Now you need only bring either your own head into an inclined position, or the diagram with the lines, and repeat the experiment, putting your head at first into such a position that the centre of the diagram corresponds with the primary direction of the visual line, and moving afterwards the eye along the lines *a b* or *c d*, and you will find the ocular spectrum of the colored line coinciding with those black lines which are parallel with *a b*. In this way, therefore, you can easily prove the law of Listing for every possible direction of the visual line.

I found the results of these experiments in complete agreement with the law of Listing for my own eyes, and for those of several other persons with normal power of vision. The eyes of very short-sighted persons, on the contrary, often show irregularities, which may be caused by the elongation of the posterior part of those eyes.

These motions of our eyes are a peculiar instance of motions, which, being quite voluntary, and produced by the action of our will, are nevertheless limited as regards their extent and their combinations. We find similar limitations of motion of the eyes in other cases also. We cannot turn one eye up, the other down; we cannot move both eyes at the same time to the outer angle; we are obliged

to combine always a certain degree of accommodation of the eyes to distance, with a certain angle of convergence of their axes. In these latter cases it can be proved that the faculty of producing these motions is given to our will, although our will is not commonly capable of using this faculty. We have come by experience to move our eyes with great dexterity and readiness, so that we see any visible object at the same time single and as accurately as possible; this is the only end which we have learnt to reach by muscular exertion; but we have not learnt to bring our eyes into any given position. In order to move them to the right, we must look to an object situated on our right side, or imagine such an object and search for it with our eyes. We can move them both inwards, but only when we strive to look at the back of our nose, or at an imaginary object situated near that place. But commonly there is no object which could be seen single by turning one eye upwards, the other downwards, or both of them outwards, and we are therefore unable to bring our eyes into such positions. But it is a well-known fact, that when we look at stereoscopic pictures, and increase the distance of the pictures by degrees, our eyes follow the motion of the pictures, and that we are able to combine them into an apparently single object, although our eyes are obliged to turn into diverging directions. Professor Donders, as well as myself, has found that when we look to a distant object, and put before one of our eyes a prism of glass, the refracting angle of which is between 3 and 6 degrees, and turn the prism at first into such a position before the eye that its angle looks to the nose and the visual lines converge, we are able to turn the prism slowly, so that its angle looks upwards or downwards, keeping all this time the object apparently single at which we look. But when we take away the prism, so that the eyes must return to their normal position before they can see the object single, we see the object double for a short time—one image higher than the other. The images approach after some seconds of time and unite at last into one.

By these experiments it is proved that we can move both eyes outward, or one up and the other down, when we use them under such conditions that such a position is required in order that we may see the objects single at which we are looking.

I have sometimes remarked that I saw double images of single objects, when I was sleepy and tried to keep myself awake. Of these images one was sometimes higher than the other, and sometimes they were crossed, one of them being rotated round the visual line. In this state of the brain, therefore, where our will begins to lose its power, and our muscles are left to mere involuntary and mechanical impulses, an abnormal rotation of the eye round the visual line is possible. I infer also from this observation, that the rotation of the eye round the visual axis cannot be effected by our will, because we have not learnt by which exertion of our will we are to effect it,

and that the inability does not depend on any anatomical structure either of our nerves or of our muscles which limits the combination of motion. We should expect, on the contrary, that, if such an anatomical mechanism existed, it should come out more distinctly when the will has lost its power.

We may ask, therefore, if this peculiar manner of moving the eyes, which is determined by the law of Listing, is produced by practical exercise on account of its affording any advantages to visual perceptions. And I believe that certain advantages are indeed connected with it.

We cannot rotate our eyes in the head, but we can rotate the head with the eyes. When we perform such a motion, looking steadily to the same point, we remark that the visible objects turn apparently a little round the fixed point, and we lose by such a motion of our eye the perception of the steadiness of the objects at which we look. Every position of the visual line is connected with a determined and constant degree of rotation, according to the law of Donders; and in altering this rotation we should judge the position of external objects wrongly.

The same will take place when we change the direction of the visual line. Suppose the amplitude of such motions to be infinitely small; then we may consider this part of the field of vision, and the corresponding part of the retina on which it is projected, as plane surfaces. If during any motion of the eye the optic image is displaced so that in its new position it remains parallel to its former position on the retina, we shall have no apparent motions of the objects. When, on the contrary, the optic image of the visible objects is dislocated so that it is not parallel to its former position on the retina, we must expect to perceive an apparent rotation of the objects.

As long as the motions of the eye describe infinitely small angles, the eye can be moved in such a way that the optic image remains always parallel to its first position. For this end the eye must be turned round axes of rotation which are perpendicular to the visual line; and we see indeed that this is done, according to the law of Listing, when the eye is moving near its primary position. But it is not possible to fulfil this condition completely when the eye is moved through a wider area which comprises a larger part of the spherical field of view. For if we were to turn the eye always round an axis perpendicular to the visual line, it would come into very different positions after having been turned through different ways to the same final direction.

The fault, therefore, which we should strive to avoid in the motions of our eye, cannot be completely avoided, but it can be made as small as possible for the whole field of vision.

The problem, to *find such a law for the motions of the eye that the sum of all the rotations round the visual line for all possible infinitely*

small motions of the eye throughout the whole field of vision becomes a minimum, is a problem to be solved by the calculus of variations. I have found that the solution for a circular field of vision, which corresponds nearly to the forms of the actual field of vision, gives indeed the law of Listing.

I conclude from these researches, that the actual mode of moving the eye is that mode by which the perception of the steadiness of the objects through the whole field of vision can be kept up the best; and I suppose, therefore, that this mode of motion is produced by experience and exercise, because it is the best suited for accurate perception of the position of external objects.

But in this mode of moving, rotations round the visual line are not completely avoided when the eye is moved in a circular direction round the primary position of the visual line; and it is easy to recognize that in such a case we are subject to optical illusions.

Turn your eyes to a horizontal line situated in the highest part of the field of vision, and let them follow this line from one end to the other. The line will appear like a curved line, the convexity of which looks downward. When you look to its right extremity, it seems to rise from the left to the right; when you look to the left extremity of the line, the left end seems to rise. In the same way, all straight lines which go through the peripheral parts of the field of vision appear to be curved, and to change their position a little, if you look to their upper or their lower ends.—*Proceedings of the Royal Society.*

[To be continued.]

THE BOSTON MEDICAL AND SURGICAL JOURNAL.

BOSTON: THURSDAY, NOVEMBER 3, 1864.

Proceedings of the Nineteenth Annual Meeting of the Ohio State Medical Society, June 21st and 22d, 1864.—A pamphlet of some 90 pages is rather a small annual contribution from the Society of so large a State as Ohio, but better a small publication, if it be a good one, than a large, dilute, watery one. The one before us contains several papers of merit and practical value.

The Valedictory Address by the retiring President, Dr. W. P. Kincaid, is in the usual strain of such compositions. It is to our minds a positively cruel custom which exists in some of our State Societies, which compels the retiring President, on each recurring anniversary, to reiterate the old commonplaces pertaining to the dignity, the great responsibilities and high moral standing of the medical profession, and to make an effort at eloquence in attempting to stir up his audience to a fresh appreciation of them. In the address before us, the author bestows the usual attention on these topics, and dwells with a good deal of emphasis, also, on the value of a general education to a phy-

sician, as an indispensable preparation for his profession, but one which we are led to infer has only of late come to be considered of much importance in Ohio. Most cordially do we agree with the honored Ex-President in this, and hope his words may sink down into the hearts of his hearers and readers.

A Report on Diseases of the Eye, by Dr. A. Metz, of Masillon, seems to have been prepared by one thoroughly conversant with his subject. Considerable space in this article is given to the subject of strabismus, the object being to show that the text-books are far behind the actual state of knowledge and practice in this important operation. It contains abstracts from several recent publications of authority, and may be profitably consulted by any surgeon who looks upon the operation as a very simple one and to be done in the same manner, whatever the amount of deviation, or the condition of the antagonist muscle. The author also very properly speaks at some length on the subject of glaucoma, not so much to enunciate any new views, as to enlighten his hearers (of whom it is quite likely some were not before so fully informed) with regard to the great gravity of this obscure affection and the vital importance of prompt surgical interference to save the sight of those attacked by it. He quotes from his own experience a case under the care of a respectable physician, who positively refused to allow him to operate until all inflammation had subsided, and two others in which saline purgatives and lead collyria comprised the whole treatment employed by the general practitioners into whose hands they were so unfortunate as to fall.

A Report on New Remedies, by Dr. Edward B. Stevens, of Cincinnati, speaks favorably of phloridzine as a substitute for quinia, and recommends it for its cheapness, and as being tolerated where quinia is not. The author discusses the alleged virtues of *saracenia purpurea* as a remedy for smallpox, and comes to the sensible conclusion that they exist rather in imagination than in reality. Other remedies which have come into prominent notice of late are duly considered.

A report from Dr. Thaddeus A. Reamy, of Zanesville, Ohio, on Asthma, is the next paper in order. The author was appointed a Committee on this subject, probably because he had been himself a sufferer from this terrible malady. An attempt on his part to elicit the views of his medical brethren of Ohio on this subject resulted in his getting but five answers to the circular which he issued; a result certainly speaking very little for the professional courtesy, to say the least, of those to whom it was addressed. He offers no views on the pathology of this disease which can claim the interest of novelty, but accepts the theory of bronchial spasm as being at the foundation of it. In the course of his remarks on treatment he says of the use of remedies:

"The articles selected ought to be chosen according to the symptoms of each case, and their known effect upon the patient. I have in this connection to urge their early employment, because more than half the attacks of asthma can be cut short by a full dose of ipecac, if the remedy be employed when the first arrears in breathing are experienced. Attention is called to this fact by Dr. Salter, and in my own practice I have witnessed repeated proofs of its importance. I have a case under my care at this time—a lady who has been a sufferer for five years—the attacks approaching regularly every three months, and lasting from six to ten days with great severity. So far

the intervals have been complete. For twelve months she has had no attack lasting more than an hour, and not severe. The ipecac has been promptly administered at the very outset of each attack, in sufficient quantity to insure vomiting, and the spasm at once arrested. I cannot too strongly urge upon my professional brethren the importance of this simple rule in treatment. The asthmatic tendency may be completely thwarted in many cases, and the patient escape untold agony, simply because the remedy acts before great pulmonary congestion has occurred. Urge upon your patient to take the medicine, whether it be day or night, immediately upon the first symptom of dyspnœa."

Of the internal use of nitrate of potash in asthma, Dr. Reamy has a very favorable opinion. We quote him as follows :—

"I have prescribed this article in forty-eight cases with the following results :—Ten cases have fully recovered. Sixteen have been materially improved, the intervals becoming longer and the attacks milder. In the remaining twenty-two cases no manifest improvement has been discovered. Most of the cases which have recovered were complicated either with dyspepsia or bronchitis, some of them with both. This may partly explain the success of the remedy; for although I cannot believe that either of these diseases can beget the nervous asthmatic predisposition, I can easily understand how they may call it into action where it exists. And I have found no article of the materia medica more effectual in subduing chronic bronchial inflammation than nitrate of potash. And notwithstanding the almost universally received opinion that whatever opposes putrefaction out of the body, retards digestion in the body, I have long prescribed this article in asthenic dyspepsia with the happiest effects. It stimulates to healthy action the feeble stomach. It has been my custom to dissolve an ounce of the salt (pure) in a pint of distilled water, and order of the resulting solution a tablespoonful three times daily after meals. In this way it will be seen that fifteen grains of the salt are administered at a dose well diluted. Precisely how it acts in curing asthma I do not know. The remedy seems to have no direct effect upon the paroxysms of the disease, and I never prescribe it for immediate relief. In order to success, it must be continued several months, during the interval as well as during the paroxysm. Gradually the paroxysms grow lighter, the interval longer, the stomach and bowels assume a more healthy condition. The bronchial inflammation, where it exists, yields, and the patient at last finds himself free from a malady which renders life a burden. Whether this article acts solely by influence upon the bronchial irritation and diseased stomach, and therefore becomes useless except in cases thus complicated, I cannot say, as my experience has not been sufficient to determine. I have already said that these complications seemed to exist in the cases which recovered in my hands. Whether in the very important changes wrought in the blood, a new nervous force results, and therefore a destruction of that peculiar asthmatic nervous susceptibility, I cannot determine; such a state of affairs, however, may be possible. As the patient is not protected from the influence of atmospheric change by any precaution as to clothing or otherwise, an increased activity in the secretion of urine is generally found, and I suspect that the kidneys play no unimportant part in the 'good work.' I may be pardoned for

adding that among the fortunate cures effected by this remedy, your Committee gratefully stands. After four years of untold suffering I completely recovered, and have now been clear of the disease more than three years, with no threatenings of a return. I hope members of the profession will give nitrate of potash a fair and impartial trial, and make known the results of their observations. I am sanguine that much good can be done with this article. I do not regard it as a specific. I do not believe in specifics. I do not suppose that half the cases of asthma will be materially improved by its most judicious employment. And yet if a radical cure of one fiftieth of the cases can be effected, incalculable suffering will be avoided."

A case of Gun-shot Wound, with a fatal result, attributed by the author to delayed amputation, closes these Transactions. Judging from its tone, we are led to think he is disposed to generalize from too limited a number of facts.

A Convention of dentists from different parts of Connecticut was held in Hartford, Oct. 20th, for the purpose of organizing a State Dental Society. A permanent organization was effected as follows:—President, Dr. A. D. Hill, Norwalk; Vice President, W. W. Sheffield, New London; Recording Secretary, James McManus, Hartford; Corresponding Secretary, L. D. Pelton, Hartford; Treasurer, E. E. Crofoot, Hartford; Librarian, Charles P. Graham, Middletown; Executive Committee, Drs. Mallett, Metcalf and Stephens. The first annual meeting of the Society will be held in Hartford on the third Tuesday in May, 1865.

The operation of lithotomy was recently performed in Norwich, Ct., by Dr. C. M. Carleton, of that city—the stone being of the "mulberry" class, and weighing 331 grains.

VITAL STATISTICS OF BOSTON.

For the Week ending Saturday, October 29th, 1864.

DEATHS.

	Males.	*Females.*	*Total.*
Deaths during the week	49	36	85
Ave. mortality of corresponding weeks for ten years, 1853—1863,	36.5	36.7	73.2
Average corrected to increased population	00	00	78.7
Death of persons above 90	0	1	1

The following communications have been received:—Case of Uterine Hæmorrhage; Labor attended with Arm Presentation; Advisory Boards for Insane Asylums; Operations in the Department of Ophthalmic Surgery in the Boston City Hospital.

Books Received.—A Memorial of John C. Dalton, M.D. An Address delivered before the Middlesex North District Medical Society, April 24, 1864. By John O. Green, M.D., of Lowell. Cambridge: University Press. 1864.

Married,—At Philadelphia, 25th inst., Dr. Charles H. Alden, U.S.A., to Miss Kate Russell, daughter of E. Lincoln, Esq.

Deaths in Boston for the week ending Saturday noon, Oct. 29th, 85. Males, 49—Females, 36.—Accident, 5—apoplexy, 2—congestion of the brain, 1—disease of the brain, 4—inflammation of the brain, 1—cholera infantum, 3—consumption, 17—convulsions, 2—croup, 2—cyanosis, 1—debility, 1—dementia, 1—diarrhœa, 1—dropsy, 5—dropsy of the brain, 2—dysentery, 2—scarlet fever, 2—typhoid fever, 3—disease of the heart, 3—infantile disease, 3—disease of the kidneys, 1—laryngitis, 1—disease of the liver, 1—congestion of the lungs, 1—inflammation of the lungs, 4—old age, 2—paralysis, 1—peritonitis, 1—premature birth, 1—smallpox, 5—disease of the spine, 1—unknown, 5.

Under 5 years of age, 27—between 5 and 20 years, 9—between 20 and 40 years, 17—between 40 and 60 years, 17—above 60 years, 15. Born in the United States, 47—Ireland, 30—other places, 8.